Syntax and Semantics
Today's Lecture

- Compounds: Templates, Templates, ...

- Syntax
  - The acceptable form of what we write
  - Mathematically, a set <prog>
  - Backus and Nauer From (BNF)

- Semantics
  - The meaning of syntax
  - Mathematically, well, we’ll see
Shape = Triangle | Square

- *Shape* will combine two things:
  - (define-struct triangle (base height))
  - (define-struct square (side))

- Now we can talk about *shape* as either
  - (triangle b h) where b and h are numbers, or
  - (square s) where s is a number

- Functions that consume *shape* must follow a *template*
Template (for deconstruction)

; x : shape

(cond [(triangle? x)
(... (triangle-base x)
  (triangle-height x))]]
[(square? x)
(... (square-side x))]) )
Instance of template

; area : shape -> number
(define (area x)
    (cond [(triangle? x)
            (* 0.5 (* (triangle-base x)
                        (triangle-height x)))]
          [(square? x)
           (sqr (square-side x))])))
Recall from lecture 3

- A syntactically correct program can be
  - An atom, like a number 17, `rabbit, of a variable \textit{radius}, or
  - A compound program,
    - starting with (,
    - followed by \texttt{operator (variable name)}
    - then \texttt{one (for now) or more programs}
    - and, finally, ending with )

- Syntax errors: 3), (3 + 4), [+ 3 1], )+(, …
Syntax

- For variables, constants, and primitives

<var> = x | area-of-disk | perimeter | ...
<con> = true | false | 'a | ‘ringo ...

\[ 1 \mid -1 \mid \frac{3}{5} \mid 1.22 \mid ... \]

<prm> = + \mid - \mid ...
Syntax

- Now we can look at expressions:
  
  \[
  \langle \text{exp} \rangle = \langle \text{var} \rangle \mid \langle \text{con} \rangle \mid (\langle \text{prm} \rangle \langle \text{exp} \rangle \ldots \langle \text{exp} \rangle ) \\
  \mid (\langle \text{var} \rangle \langle \text{exp} \rangle \ldots \langle \text{exp} \rangle ) \\
  \mid (\text{cond} (\langle \text{exp} \rangle \langle \text{exp} \rangle ) \ldots (\langle \text{exp} \rangle \langle \text{exp} \rangle )) \\
  \mid (\text{cond} (\langle \text{exp} \rangle \langle \text{exp} \rangle ) \ldots (\text{else} \langle \text{exp} \rangle ) )
  \]

- And definitions:

  \[
  \langle \text{def} \rangle = (\text{define} (\langle \text{var} \rangle \langle \text{var} \rangle \ldots \langle \text{var} \rangle ) \langle \text{exp} \rangle ) \\
  \mid ?
  \]
Semantics

- Defined by explaining each syntactic entity in our language
  - `<exp>`
    - `<var>` means return the associated value
    - `<con>` means return this constant
  - `<def>`
    - `(define ...) means introduce new variable, ...`

- Read this chapter very carefully!